



Conceptual Site Model for Uranium Contamination Beneath the 300 Area

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VOC Investigation

Integrated Field-Scale Challenge Test Site

Uranium Treatability Test Site

300 AREA, VIEW TO THE SOUTH
(MARCH 2007)

Conceptual Site Model Defined:

- ▶ **Primary role of the CSM under CERCLA is “to describe what is known or can be inferred about a site for the purpose of *making a decision*”⁽¹⁾**
 - Identifies sources for contaminants, media and pathways, receptors
 - Use: Assist in screening remedial technologies and alternatives
 - CSM for a site evolves over time and becomes more focused
 - CSM and conceptual models, hypotheses, etc.

- ▶ **The CSM described in the following presentation is focused on:**
 - Uranium contamination in 300 Area groundwater.
 - Providing the technical information to help select a remedial action for reducing concentrations in groundwater.

⁽¹⁾ References: Shaw (2006); USACE (2003)

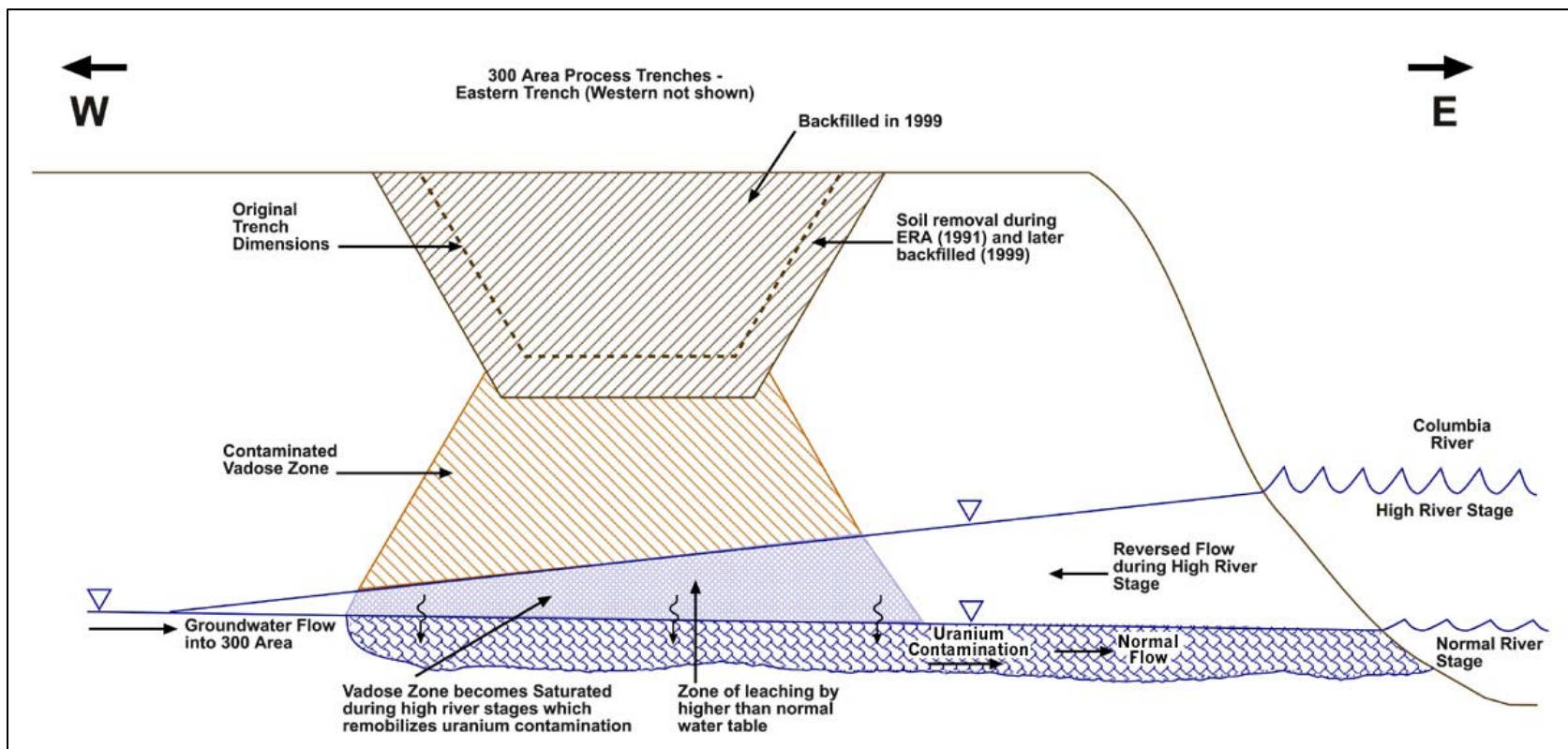
Previous Work:

► **Understanding of uranium contamination in 300 Area groundwater has evolved as a consequence of several key investigations:**

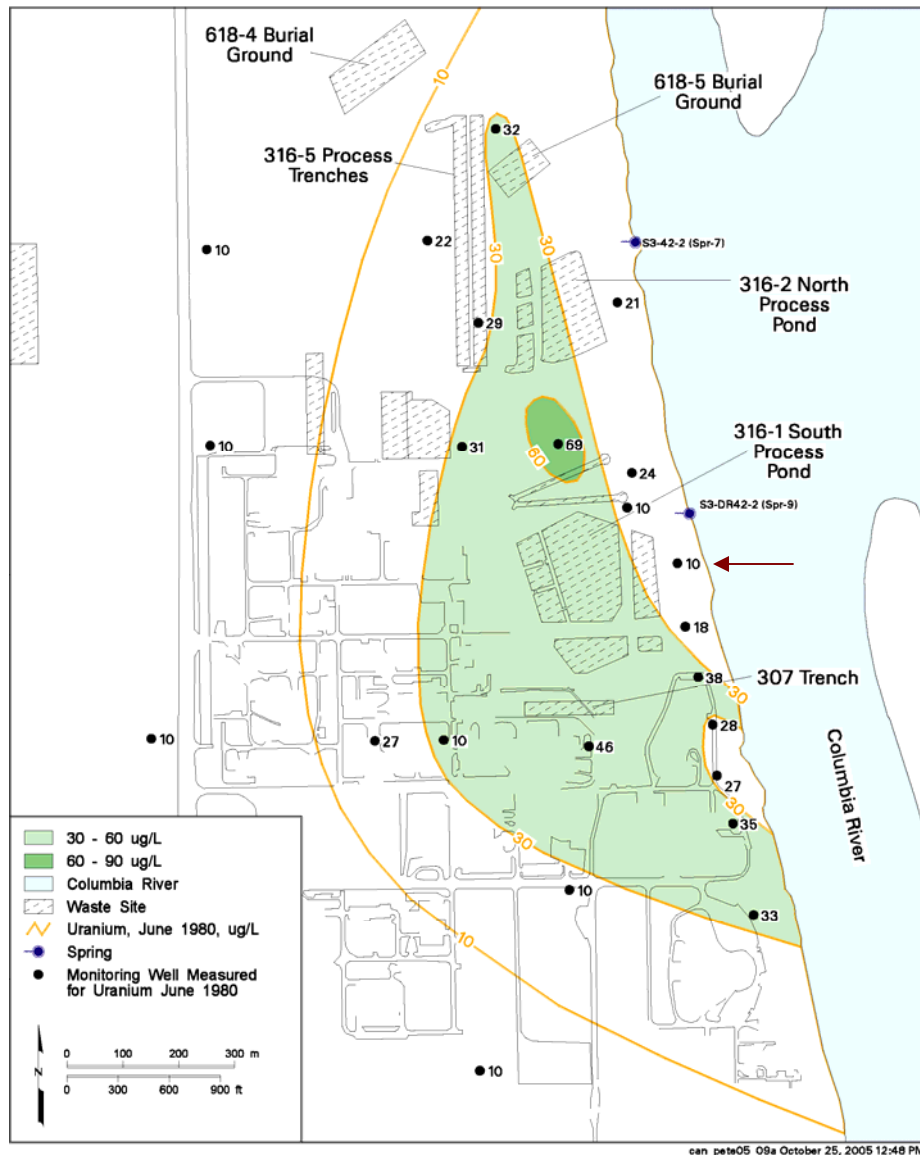
- 1979: Geohydrology and groundwater quality beneath the 300 Area
- 1988: Investigation of 300 Area Process Trenches under RCRA
- 1990-1994: Initial remedial investigation under CERCLA
- 2004: Expanded groundwater report for 300-FF-5

► **Central question remaining: Why has the uranium plume in 300 Area groundwater persisted longer than predicted?**

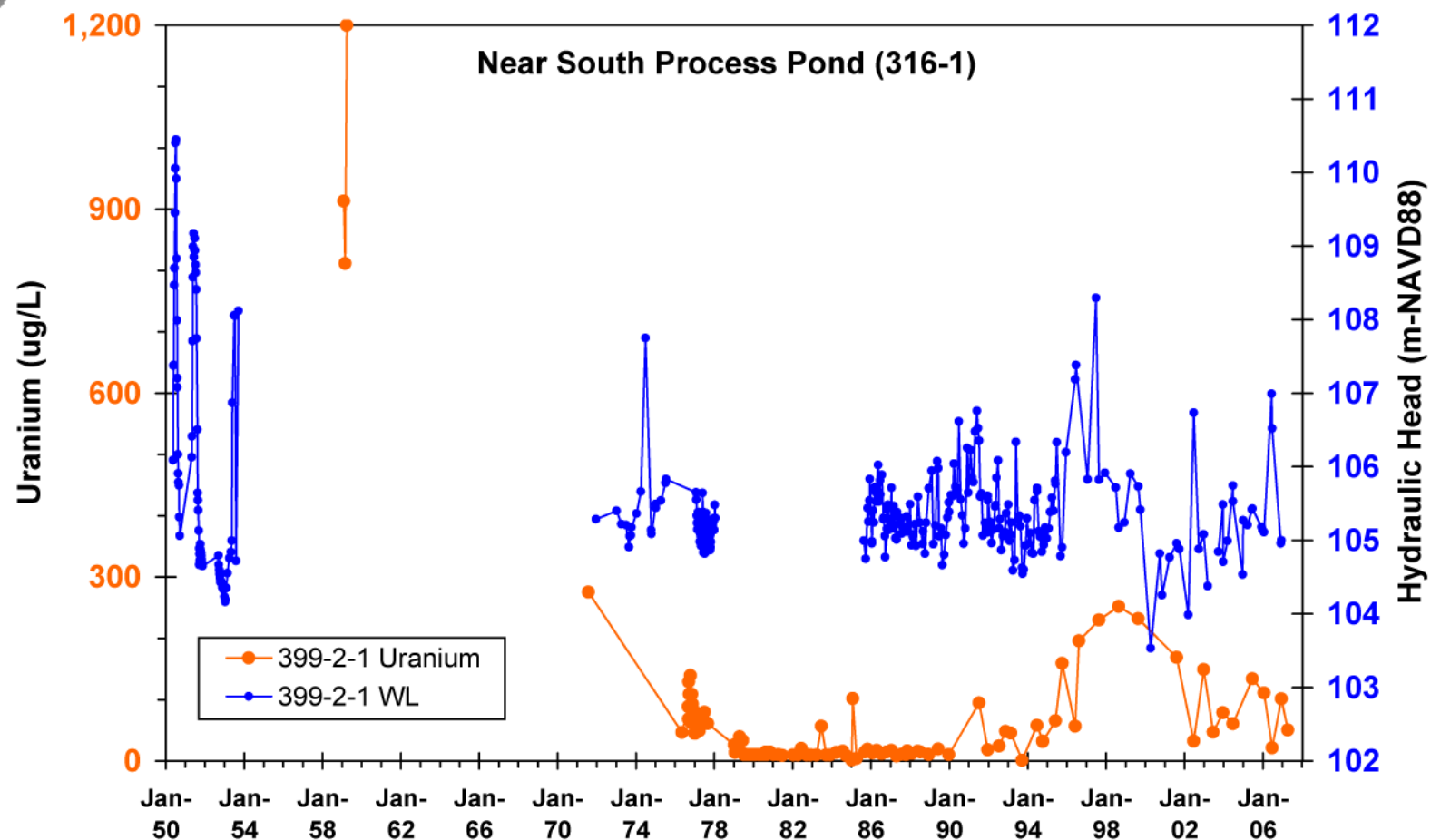
- Where is the inventory of uranium that feeds the plume?
- How is the inventory of uranium mobilized to re-supply the plume?
- How long can the inventory continue to supply uranium to the plume?



Source: Modified from PNNL-13645



Historical Trends



300 Area U History.xls (6/28/07)

Current Concepts:

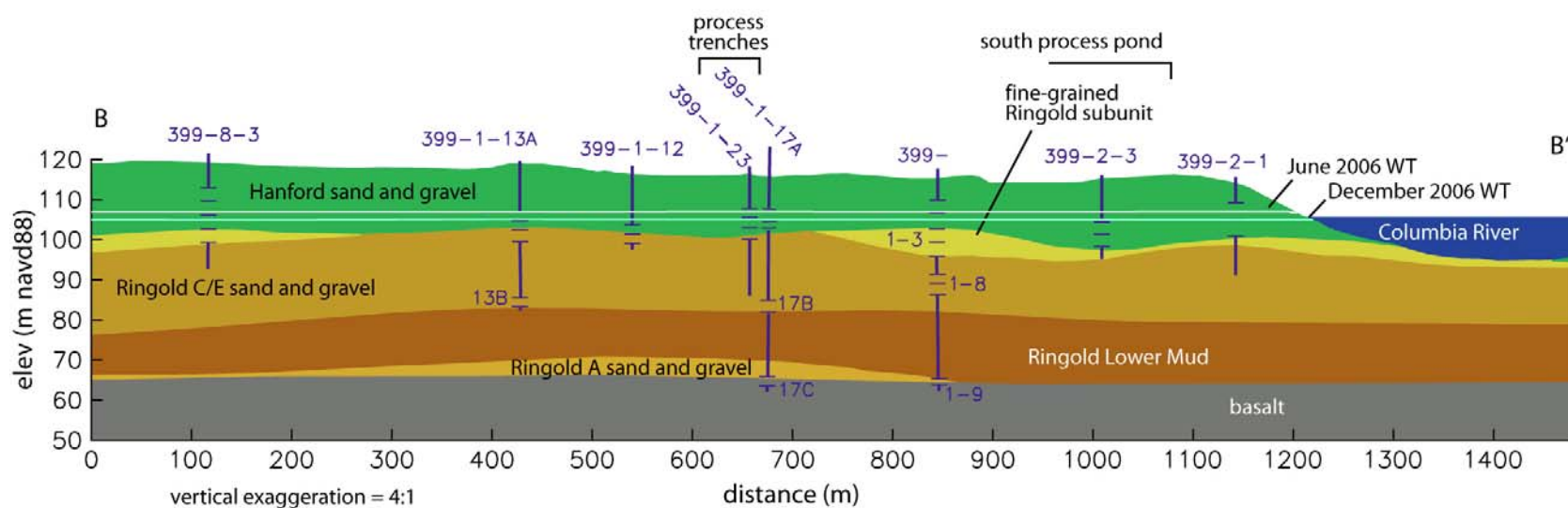
- ▶ ***Where is the inventory of uranium that feeds the plume?***
 - Vadose zone beneath former liquid waste disposal sites
 - Zone through which the water table rises and falls
 - Solid materials in the aquifer

- ▶ ***How is the inventory of uranium mobilized to re-supply the plume?***
 - Mobility is dependent on the form of the stored inventory
 - Inventory has existed under current hydrologic conditions for many years since waste disposal operations ended
 - Potential drivers include infiltration of moisture from the surface, a fluctuating water table, and groundwater flow

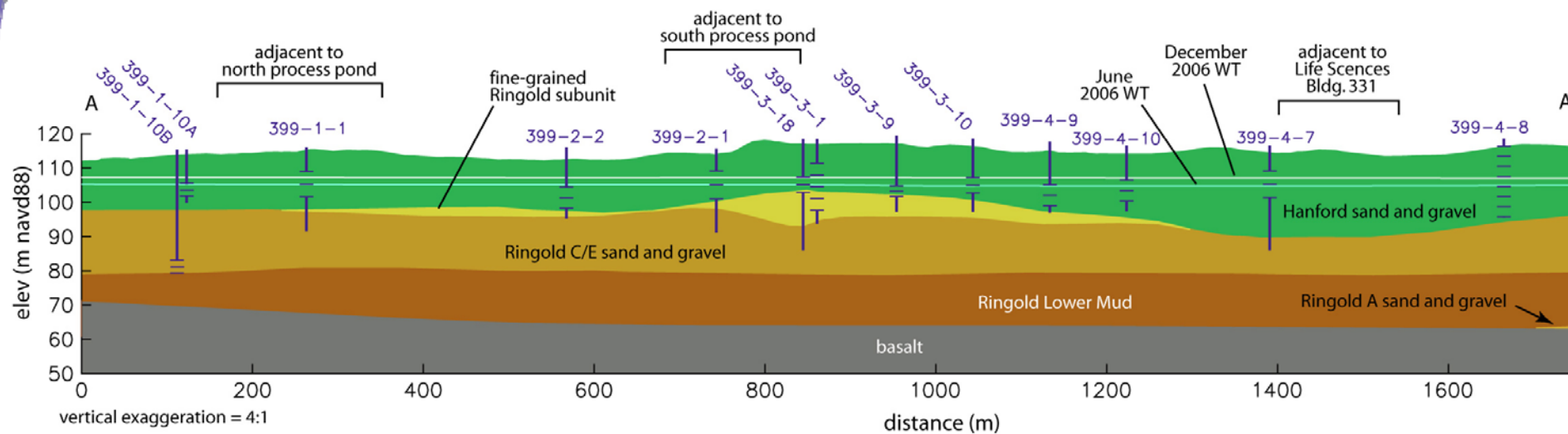
- ▶ ***How long can the inventory continue to supply uranium to the plume?***
 - Answer involves rates of release to the transporting medium and the amount stored in each of the various candidate source zones



Northwest-to-Southeast Cross Section: Northern Portion of 300 Area



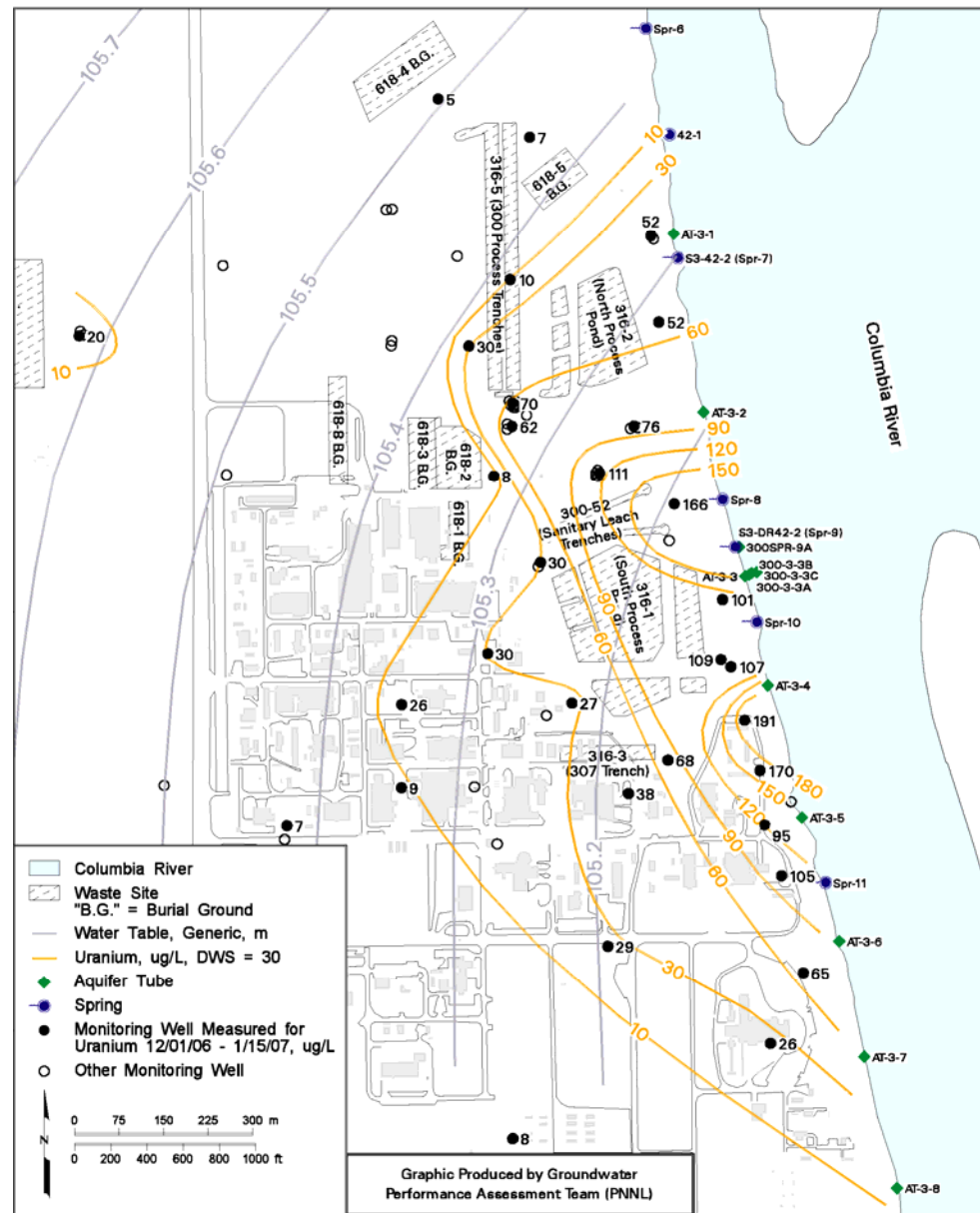
North-to-South Cross Section Along 300 Area River Shoreline



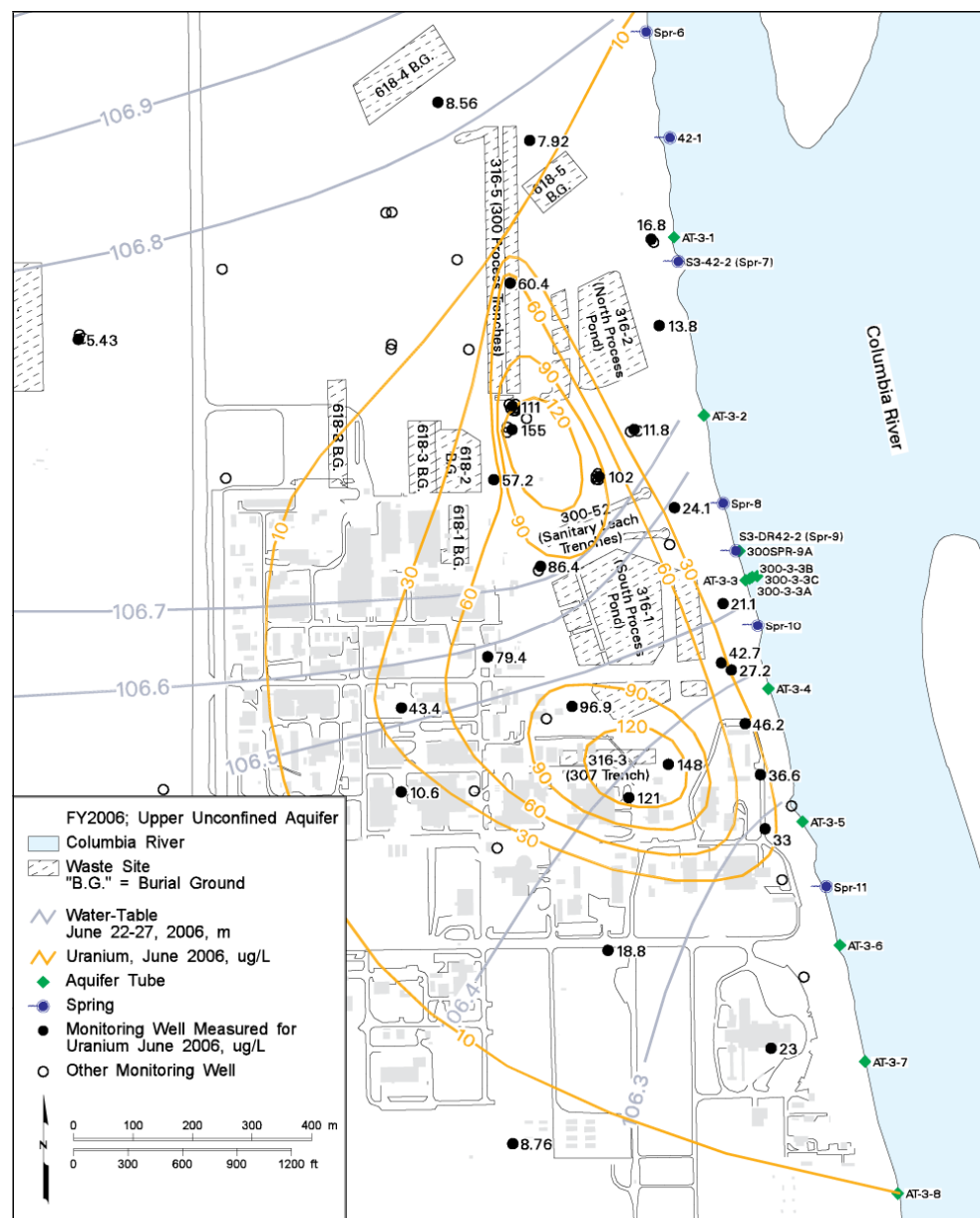
Uranium Plume in 300 Area Groundwater:

- ▶ Contaminant plume maps showing current conditions
- ▶ Seasonality in plume characteristics
- ▶ Plume parameters: Volume of contaminated groundwater and mass of dissolved uranium

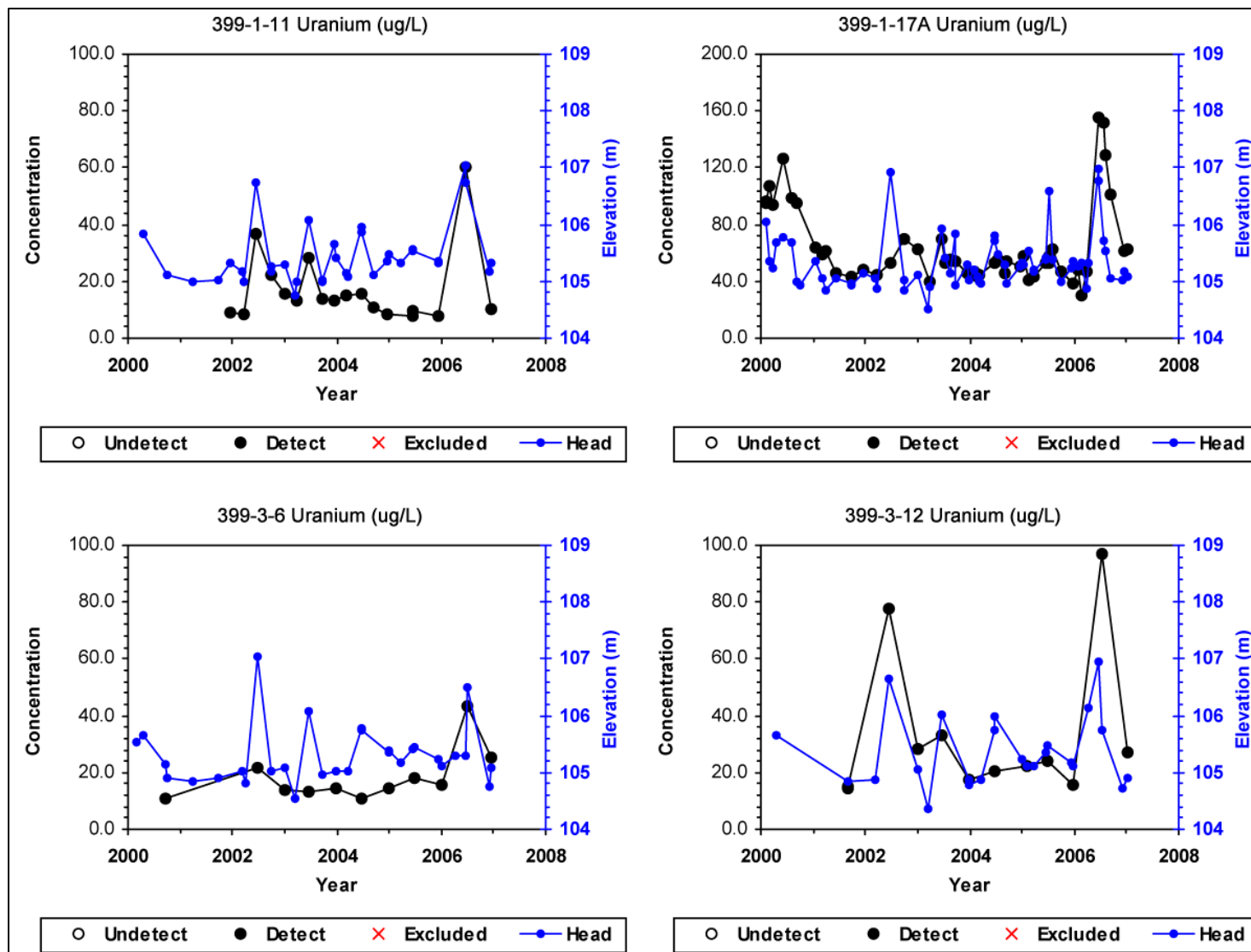
Uranium Plume: December 2006 Conditions



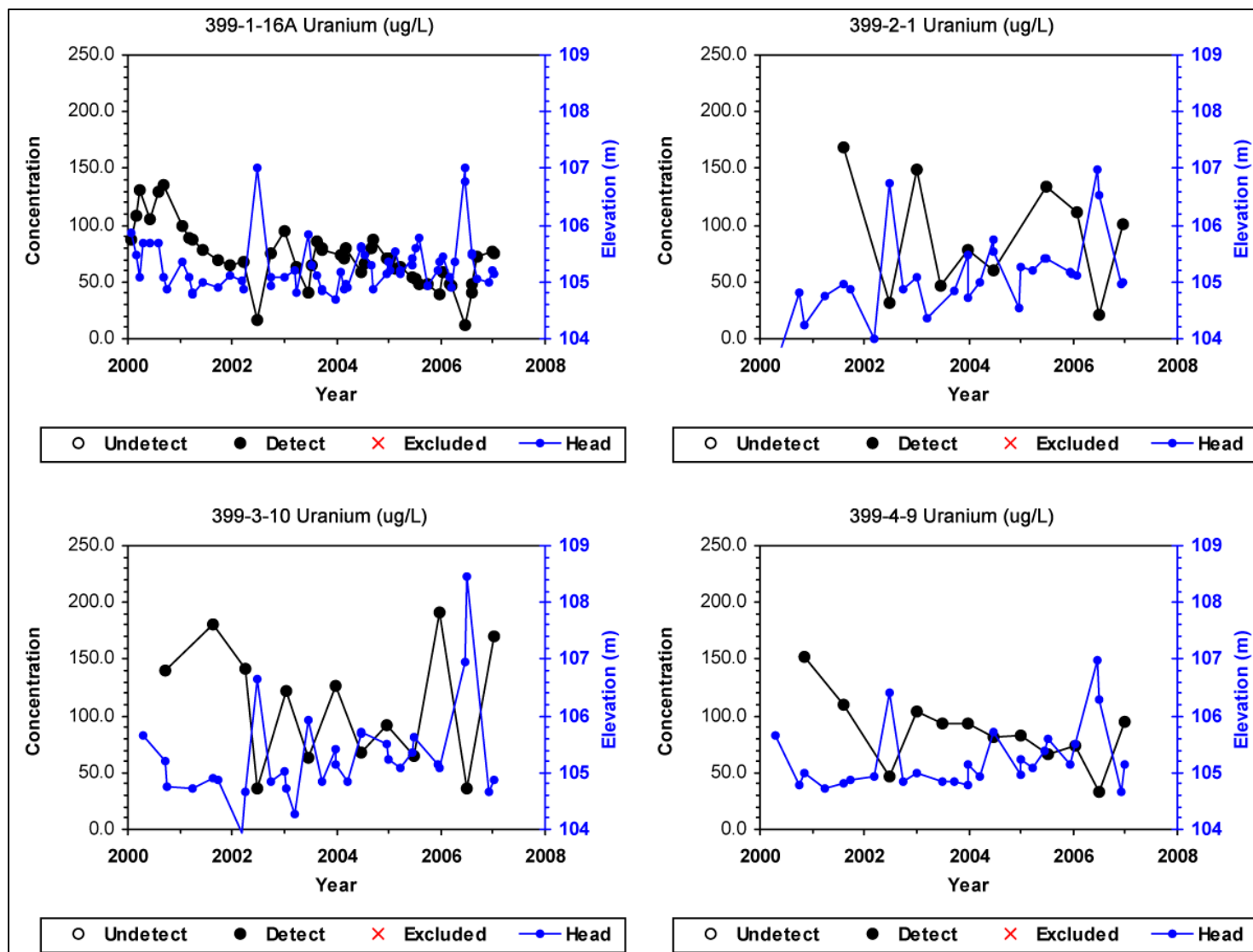
Uranium Plume: June 2006 Conditions

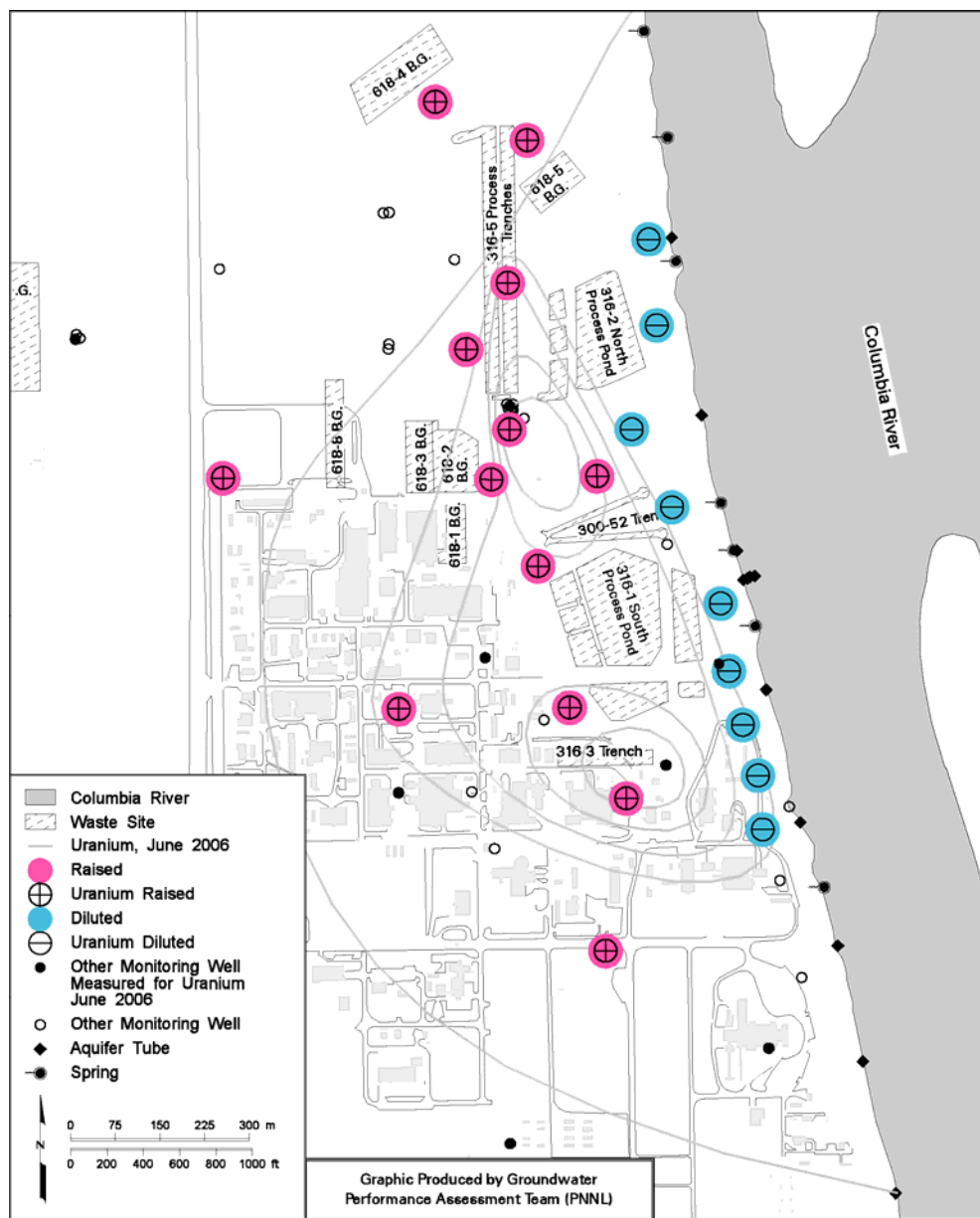


Uranium Trends at Inland Wells



Uranium Trends at Shoreline Wells





Causes for Seasonality in Uranium Plume:

- ▶ **During seasonal high water table conditions, uranium is released from the lower vadose zone to re-supply the plume.**
 - Contaminant uranium beneath former liquid waste disposal sites
 - Uranium sequestered in the “water table zone”

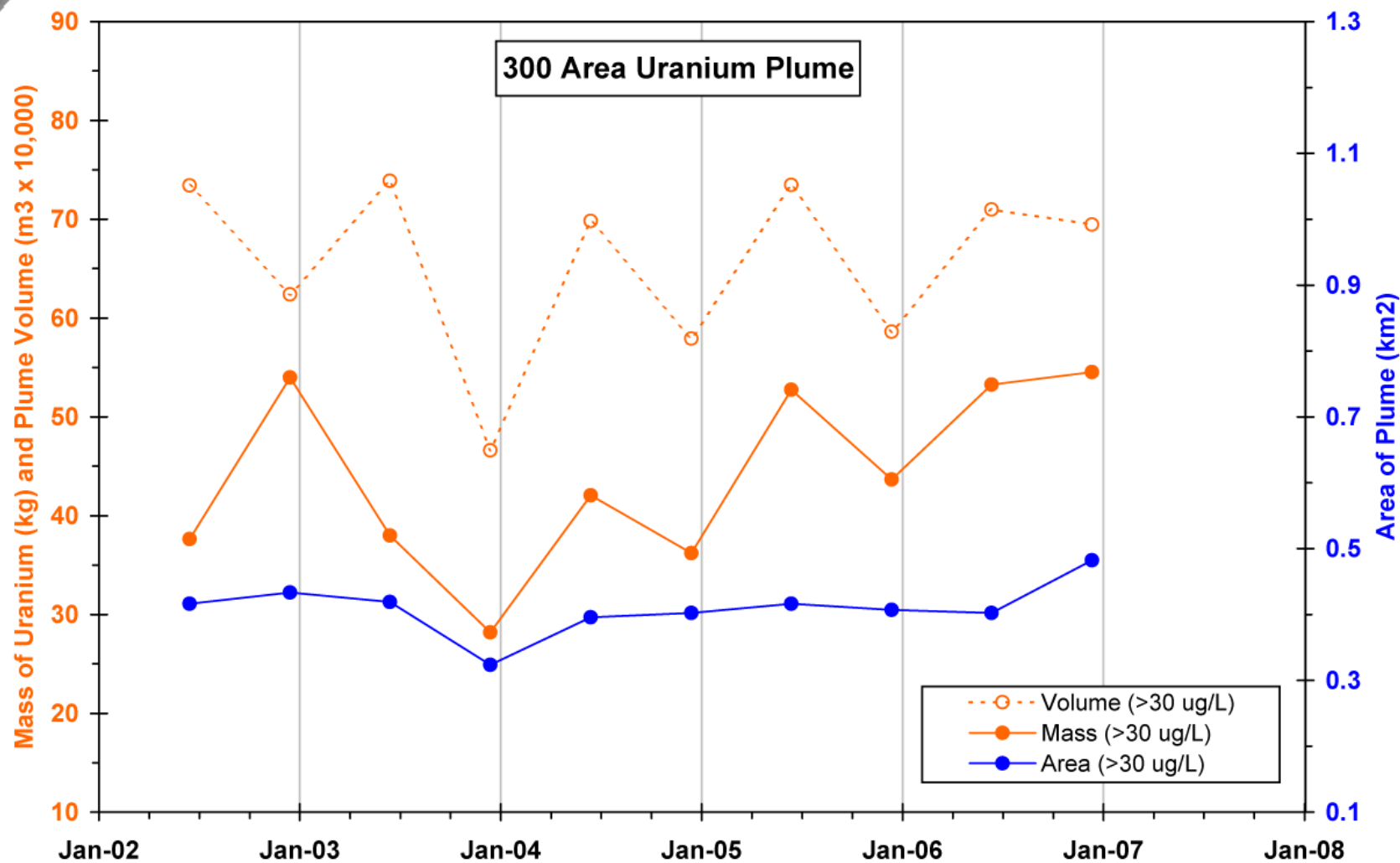
- ▶ **During seasonal high river stage conditions, river water infiltrates the banks and mixes with groundwater.**
 - Lowered specific conductance values for samples from near-river wells support this interpretation
 - River water chemistry may contribute to reducing concentration of dissolved uranium

Uranium Plume Parameters:

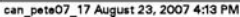
- ▶ **Parameters of interest for the uranium plume are:**
 - Area of the plume
 - Volume of contaminated groundwater
 - Mass of dissolved uranium.

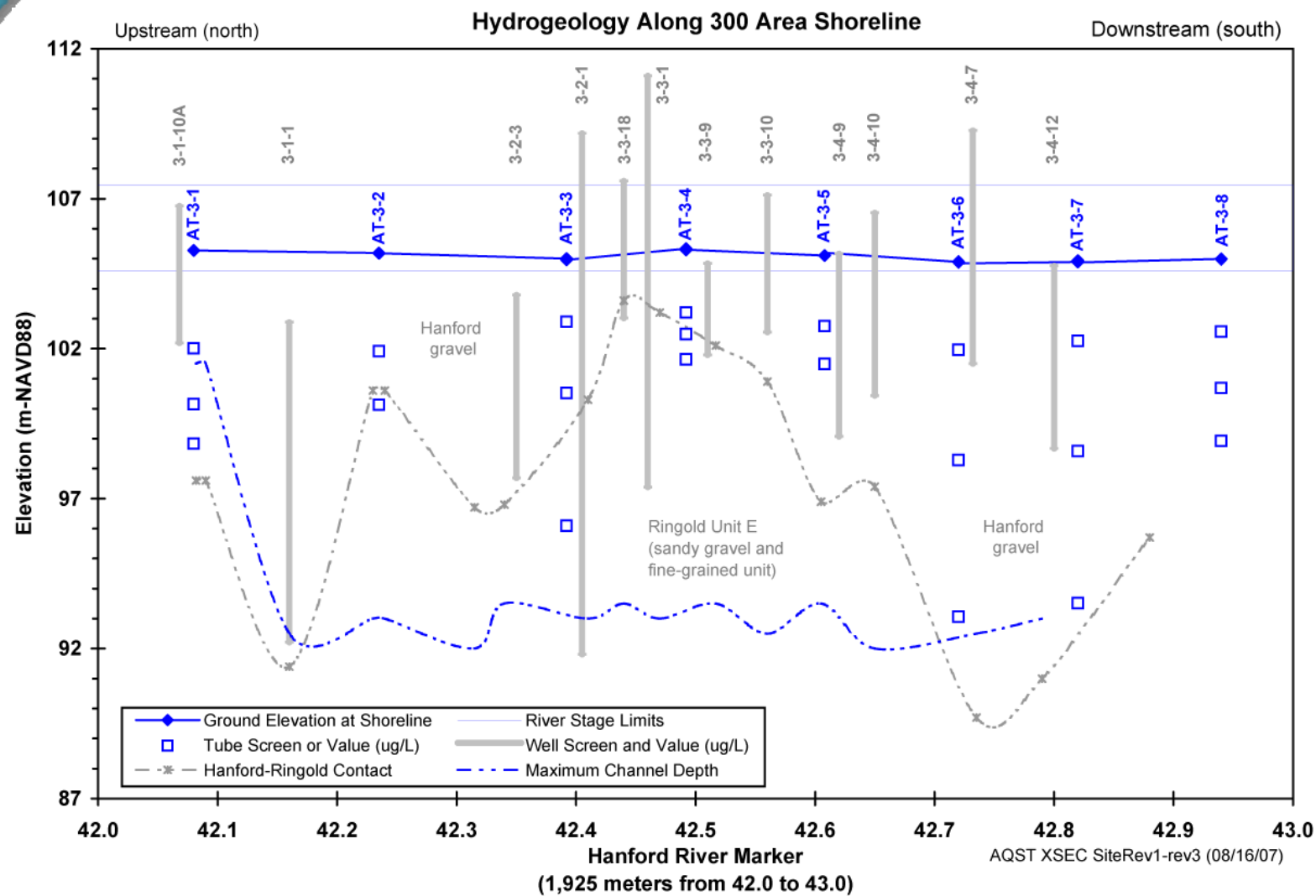
- ▶ **Essential information for:**
 - Identifying potential sources for re-supplying the plume
 - Selecting and implementing remedial action technologies

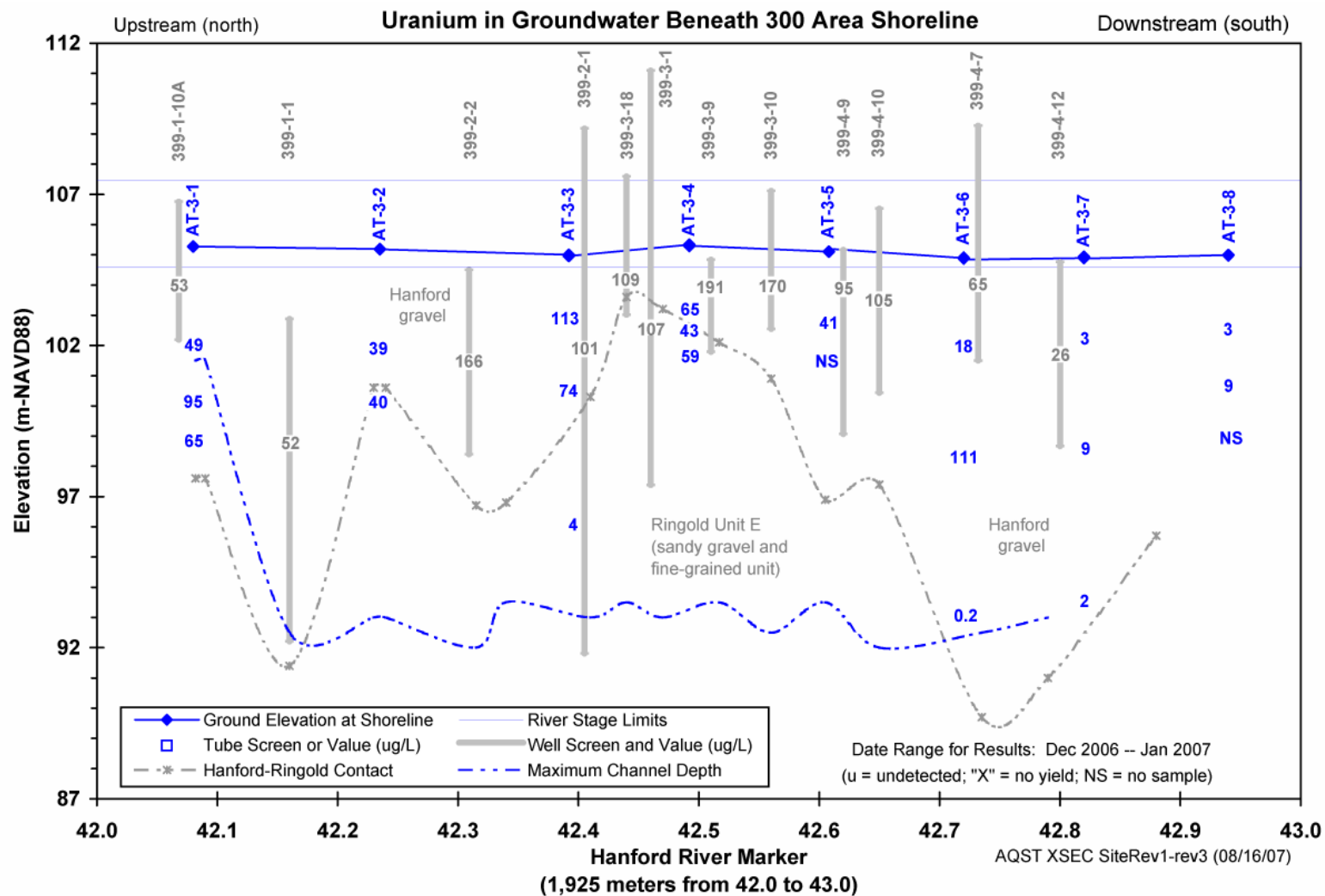
- ▶ **Long-term trends in these plume parameters, along with information on contaminant concentrations, can be used to illustrate changes in the “level” of contamination over time.**



U Plume Area-Vol-Mass-082007.xls

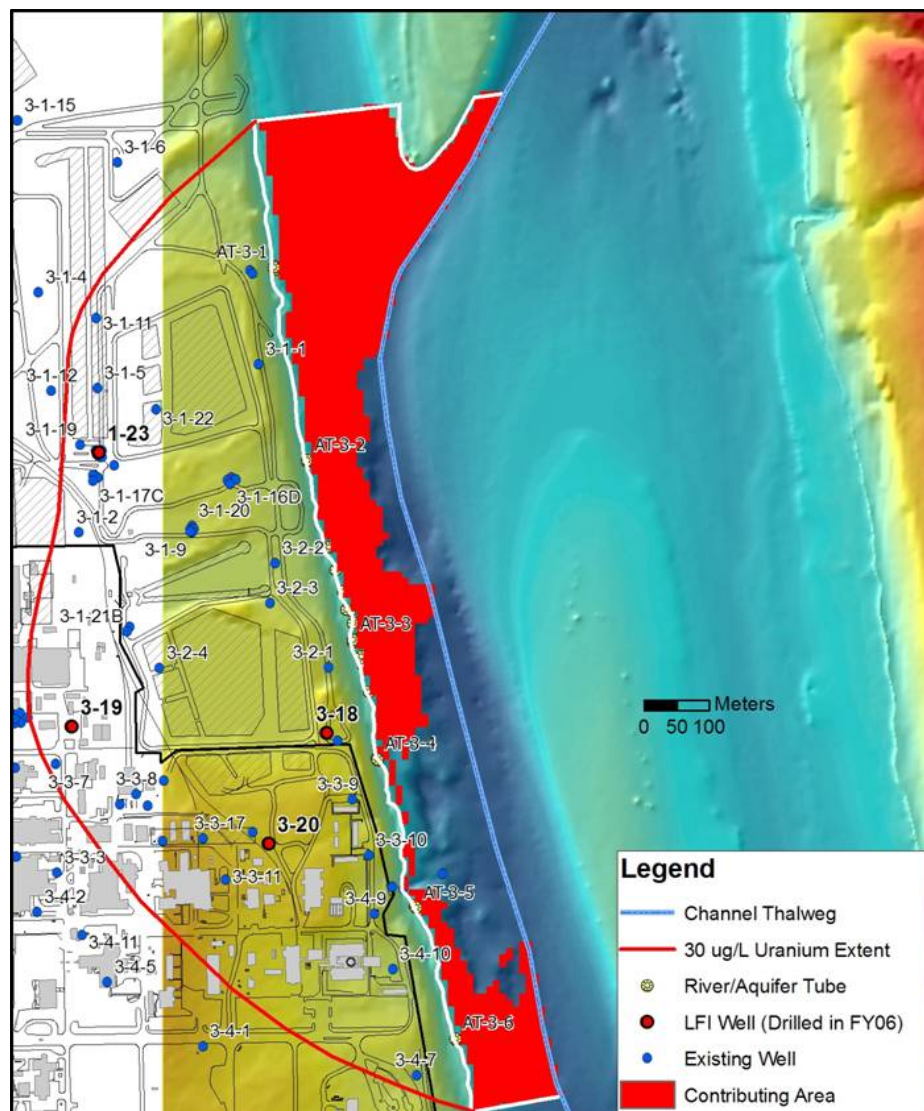






Area of Riverbed Influenced by Discharge from Saturated Hanford Gravels Unit

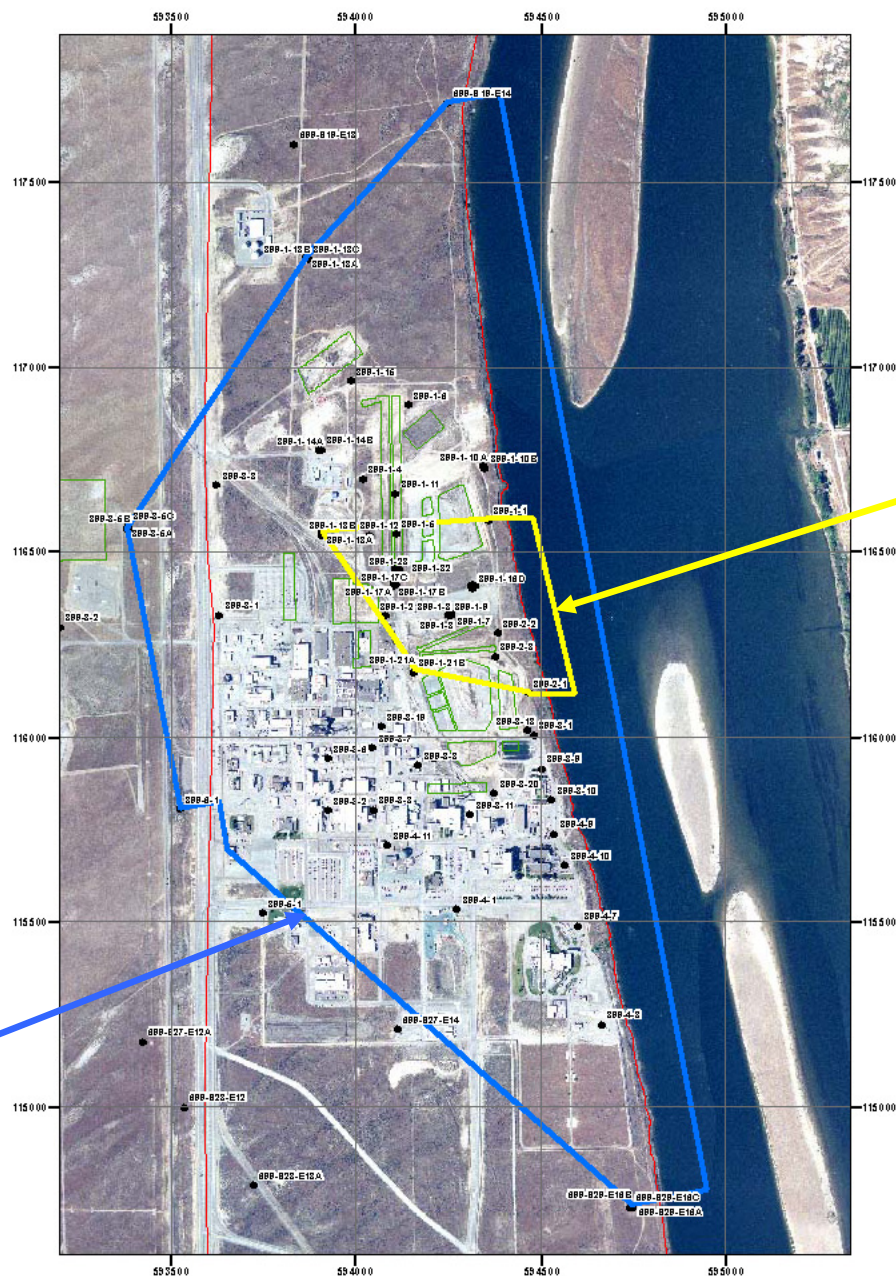
Source:
Mackley and Fritz 2007



Domains for 300 Area Groundwater Flow Models

Larger-scale model
(early 1990's
water level data)

Smaller-scale
model
(2004-2007 water
level data)



Where is the inventory of uranium that feeds the plume?

- ▶ **Vadose zone beneath remediated waste sites:**
 - Sediment at the base of excavations
 - Sediment deeper in the vadose zone; lateral spread

- ▶ **Zone through which the water table rises and falls:**
 - Beneath footprint of remediated waste sites
 - Widespread because of earlier plume and water table conditions

- ▶ **Solid materials in the aquifer:**
 - Sorbed under historically higher levels of contamination
 - Lenses of fine-grained sediment
 - Near-river zone where infiltrating river water promotes adsorption

How is the inventory mobilized to re-supply the plume?

- ▶ **Vadose zone beneath remediated waste sites:**
 - Infiltration of moisture from the surface, including natural precipitation
 - Human activities (dust control; water line breaks)

- ▶ **Zone through which the water table rises and falls:**
 - Re-saturation of lower vadose zone sediment by upward movement of groundwater when water table is elevated

- ▶ **Solid materials in the aquifer:**
 - Desorption as clean groundwater replenishes the aquifer
 - Diffusion out of lenses of low permeability zones
 - Desorption in near-river zone where infiltrating river water promotes temporary sequestration

How long can the inventory replenish the plume?

- ▶ **Vadose zone beneath remediated waste sites:**
 - Infiltration of surface moisture is minimal under current conditions
 - Form of contaminant uranium remaining is likely to be less mobile than earlier forms

- ▶ **Zone through which the water table rises and falls:**
 - Release amount is related to how high, and for what duration, the water table is elevated

- ▶ **Solid materials in the aquifer:**
 - Conditions have evolved since waste disposal began in 1943, and have likely reached some degree of “equilibrium”
 - Waste effluent residue and natural weathering-induced coatings release uranium slowly